

A prospective multicentre study of pharmacist initiated changes to drug therapy and patient management in acute care government funded hospitals

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Aims

To determine the cost savings of pharmacist initiated changes to hospitalized patients' drug therapy or management in eight major acute care government funded teaching hospitals in Australia.

Methods

This was a prospective study performed in eight hospitals examining resource implications of pharmacists' interventions assessed by an independent clinical panel. Pharmacists providing clinical services to inpatients recorded details of interventions, defined as any action that directly resulted in a change to patient management or therapy. An independent clinical review panel, convened at each participating centre, confirmed or rejected the clinical pharmacist's assessment of the impact on length of stay (LOS), readmission probability, medical procedures and laboratory monitoring and quantified the resultant changes, which were then costed.

Results

A total of 1399 interventions were documented. Eight hundred and thirty-five interventions impacted on drug costs alone. Five hundred and eleven interventions were evaluated by the independent panels with three quarters of these confirmed as having an impact on one or more of: length of stay, readmission probability, medical procedures or laboratory monitoring. There were 96 interventions deemed by the independent panels to have reduced LOS and 156 reduced the potential for readmission. The calculated savings was \$263 221 for the eight hospitals during the period of the study. This included \$150 307 for length of stay reduction, \$111 848 for readmission reduction.

Conclusions

The annualized cost savings relating to length of stay, readmission, drugs, medical procedures and laboratory monitoring as a result of clinical pharmacist initiated changes to hospitalized patient management or therapy was \$4 444 794 for eight major acute care government funded teaching hospitals in Australia.

Introduction

The quality use of medicines is a key factor in achieving positive health outcomes. Evidence indicates that there is significant scope for improvement in the use of drugs for hospitalized patients as medication related adverse events have been identified as contributing to negative clinical and economic outcomes including hospitalization and increased length of stay (LOS) [1–7]. The contribution of the various members of the healthcare team to improving medication-related outcomes is less well explored.

Pharmacists in hospitals frequently initiate changes to patients' therapy and management. The impact of these interventions has not been evaluated and quantified outside particular specialized areas of service provision [8].

The beneficial cost savings that specific components of clinical pharmacy services have on patient management have been shown in some healthcare settings [8–11]. Home-based postacute care interventions by hospital pharmacists have been demonstrated to positively impact readmission rates, total hospital stay and hospital based costs [12–14]. In addition, the benefits of clinical pharmacists have been identified in ambulatory clinics for high-risk patients [15], during the dispensing process [16, 17] and in nursing homes [18].

The projected cost savings of clinical pharmacy services provided to hospitalized patients in major acute care teaching hospitals have not been demonstrated in a robust manner. Recent studies have highlighted the positive outcomes achieved by hospital pharmacists as members of cardiovascular, pulmonary and intensive care teams [19–21]. The presence of clinical pharmacy services in hospitals in the United States of America has also been linked by association with decreased hospital mortality rates and reduced total costs of care [22, 23].

In Australia, approximately 90% of all hospitals and 100% of major government funded hospitals provide clinical pharmacy services to admitted patients [24]. Clinical pharmacist activities include medication history reviews on admission, medication management reviews during inpatient episodes, patient medication counseling, clinical reviews, therapeutic drug monitoring, selection of drug therapy, adverse drug reaction monitoring and provision of drug information [25]. While the nature of these services is well documented the evidence of benefit has primarily focused on specialized clinical areas such as oncology, psychiatry, heart failure and medication liaison services [26–29].

The current study was undertaken to investigate the economic value of the consequences of pharmacist-initiated changes to drug therapy and patient manage-

ment in major acute care government funded teaching hospitals in Australia.

Methods

Setting

Eight major government funded acute care teaching hospitals in Australia participated in the study. Seven study sites were metropolitan and one was regional (Appendix 1). All sites were tertiary referral centres with bed numbers ranging from 361 to 955, & 100 000–300 000 bed-days per annum. Ethics Committee approval was obtained at individual sites according to institutional guidelines.

Interventions

For the purpose of the study, an intervention was defined as any action by a pharmacist that directly resulted in a change to patient management or therapy [25]. Commencing in August 1998, clinical pharmacists providing inpatient services recorded specific details of consecutive interventions that they had directly and solely initiated. Each site collected data prospectively until approximately 200 consecutive interventions had been performed. On the day of the intervention, the pharmacist recorded the changes that had occurred as a direct consequence of the intervention. Specific patient demographics were recorded. With the assistance of an experienced site-coordinating senior clinical pharmacist, the episodes were classified as either: an alteration to patient monitoring, initiation of therapy, discontinuation of therapy, change of a drug, change of dosage, or other. The primary reason for initiating the intervention was recorded. Details of drug therapy before and after the pharmacist-initiated change were documented. The clinical significance of each intervention was assessed by the intervening pharmacist and reviewed by the site-coordinating pharmacist. The definitions of the clinical significance of intervention are detailed in Table 2. The total time taken by the clinical pharmacist in preparing and undertaking the intervention was recorded. At the time of patient discharge the clinical pharmacist documented actual changes to drug therapy and patient outcomes relating to the intervention.

Independent panel assessment

An independent clinical panel was convened at each participating centre and consisted of a senior medical registrar, consultant physician and senior clinical pharmacist. The panel reviewed only those interventions perceived by the clinical pharmacist as having an impact on the following: LOS, readmission probability, medical

procedures and laboratory monitoring. The panel then confirmed or rejected the clinical pharmacist's assessment and quantified the resultant changes. The criteria for assessment and quantification of these changes was based solely on review of the individual case and the collective decision of the panel with consideration of local practice and institutional policies. Interventions perceived to only result in a change in drugs were not assessed by the panel but instead referred to the site coordinating pharmacist for calculation of impact on drugs costs.

Costing assessment

The estimates for probabilities of re-admission were based on the probability (expressed as a percentage likelihood) of a readmission event occurring without the intervention compared with the probability of a readmission event after the intervention has occurred, as assessed by the independent panel. The most appropriate Diagnostic Related Group (DRG) code for the potential readmission event was allocated by a Health Information Manager. Costs were then calculated by multiplying this probability with the average cost of the assigned DRG for that hospital.

Changes to medical procedures or laboratory monitoring were examined by the panel, which allocated a probability of the event being changed as a result on the intervention. The financial impact was then calculated by multiplying this probability by the local hospital costs for that procedure or laboratory test. If local costs were not available, the agreed government scheduled reimbursement rate, Medical Benefits Schedule (MBS), was applied.

The impact of each intervention on LOS was quantified by the panel by estimating the change in the number of days, either as a whole number or to one decimal place in either a general ward or a high dependency ward (Intensive Care Unit, Coronary Care Unit or High Dependency Unit). The basis for estimates for changes was the likelihood of changes in LOS occurring if the intervention had not occurred. It was the decision of the local independent panel as to subclassification of the bed-type based on local institutional practices. The financial impact of changes in LOS was then calculated based on each hospital's average bed-day costs for the particular bed.

Changes in drug therapy were recorded from patients' medication administration records. Site drug acquisition costs were utilized. Reconstituting solutions, infusion solutions, consumables and other administration costs were not allocated a cost. The actual duration of therapy was recorded and included medication supplied by the

hospital on discharge if applicable. Injections were costed as whole vials except for antineoplastics, which were costed on the dose administered. All medication for patient self-administration, such as mouthwashes, creams or ointments were costed as whole items, that is, as unbroken commercial packs. If a dose range was prescribed, costs were based on the average dose administered. If a drug was stopped, an estimate was made of the expected hospital drug supply, including discharge medication, that was avoided. The estimate was determined by the local senior clinical pharmacist and based on duration of hospitalization after the intervention and also the duration of medication supply on discharge that would routinely be supplied depending on the individual hospital medication supply policy.

Total clinical pharmacist costs were site-specific and based on the time performing clinical activities during the study period and then calculated from salary and related overheads. The time costed did not include dispensing, research, education or administration duties. The time spent by the clinical pharmacist in preparing, documenting and undertaking each intervention was also documented and the associated costs calculated. The time taken to complete data collections forms for the study was not costed. Annualized benefits were calculated from the number of days of data collection with costs then extrapolated over the year.

Level of agreement

Levels of agreement were determined between the independent panels and the intervening pharmacists at each hospital. The panel and the intervening pharmacist were deemed to be in agreement if both assessed the same change (increase or decrease) and the same magnitude of that change. However, for LOS and readmission probability this related only to the type of change as quantification of magnitude was not performed by the intervening pharmacists. There was no assessment of the level of agreement between the different independent panels.

Results

A total of 1399 episodes of pharmacist-initiated changes to drug therapy or patient management were documented at eight sites during 24 866 inpatient separations (hospital overnight admissions), a rate of 56.3 interventions per 1000 separations. Data collection occurred over an average of 21.6 days (range 14–39 days) at each site.

There was a similar proportion of male (50.1%) and female patients (49.9%) with 59.1% over the age of 60 years and 10.8% less than 30 years of age. The Major

Table 1

Patient profile by Major Diagnostic Group (MDG)#

Major diagnostic group	Number of admission episodes (% of total)
Disease and disorders – Circulatory system	234 (16.7%)
Disease and disorders – Respiratory system	162 (11.6%)
Disease and disorders – Musculoskeletal system	136 (9.7%)
Disease and disorders – Digestive system	109 (7.8%)
Disease and disorders – Nervous system	92 (6.6%)
Disease and disorders – Myeloproliferative	88 (6.3%)
Disease and disorders – Urinary tract	78 (5.7%)
Remainder	500 (35.6%)

Patients who were involved in multiple interventions were recorded once only.

Diagnostic Category (MDC) of the patients with changes to drug therapy or management is shown in Table 1, with four MDCs accounting for 46% of the episodes.

The primary reason, the nature and the clinical significance of the pharmacist-initiated changes to drug therapy or patient management are summarized in Tables 2 & 3.

Of the 1399 interventions, 1346 (96.2%) were assessed by the intervening pharmacist to have had an impact on one or more of either length of stay, readmission probability, drug costs, medical procedures or laboratory monitoring. Five hundred and eleven interventions were referred to the independent panels for quantification of LOS, readmission probability, medical procedures and laboratory monitoring as 835 interventions impacted on drug costs alone.

There were 88 interventions deemed by the independent panels to have reduced LOS. Twenty-two interventions reduced LOS in high dependency beds (mean 2.28 days, 95% CI 1.69–2.87 days, range 1–5 days, total 41 days) and 66 reduced general ward LOS (mean 2.42 days, 95% CI 2.05–2.80 days, range 1–10 days, total 160 days). One hundred and fifty-six interventions reduced the potential for readmission. The number and financial consequence of interventions that had an impact on medication usage, laboratory monitoring and medical procedures are detailed in Table 4. The specific details of the most frequent readmissions avoided, laboratory tests initiated and procedures avoided are outlined in Table 5.

Agreement between the independent panels and the intervening pharmacists regarding the impact of the

Table 2

Primary reason for and the type of pharmacist-initiated change to patient management or therapy

	Number (% of total)
<i>Primary reason for pharmacist intervention</i>	
Decrease potential adverse events	438 (31.3%)
Increased efficacy	336 (24%)
Reduced morbidity or mortality	220 (15.7%)
Symptom control	85 (6.1%)
Cost savings	69 (4.9%)
Decreased actual adverse drug effects	55 (3.9%)
Assist compliance	30 (2.1%)
Formulary reasons	22 (1.6%)
Other reasons	144 (10.3%)
<i>Change in drug therapy or management initiated</i>	
Change in dosage of drug	429 (30.7%)
Drug treatment initiated	279 (19.9%)
Drug treatment discontinued	231 (16.5%)
Alteration to patient monitoring	161 (11.5%)
Change from one drug to another	104 (7.4%)
Other	195 (13.9%)

Table 3

Clinical significance of the pharmacist-initiated change to patient management or therapy

Clinical significance of intervention	Number (% of total)
Life saving	15 (1.1%)
Major (intervention is expected to prevent or address 'very serious' drug related problems defined as > 20% chance of noticed effect or > 5% chance of harmful effect)	351 (25.1%)
Moderate (adjustments expected to enhance effectiveness of drug therapy, producing minor reductions in patient morbidity, or a <20% chance of noticed effect)	535 (38.2%)
Minor (small adjustments and optimizations of therapy, not expected to significantly alter hospital stay or clinical outcome)	425 (30.4%)
No clinical significance	73 (5.2%)

interventions was 91.7% for LOS (high dependency), 70.5% for LOS (general), 68.8% for readmission probability, 88.8% for medical procedures and 78.6% for laboratory monitoring. During the study period, the overall savings of the pharmacists' interventions, as quantified by the independent panels, was \$263 221.

Table 4

Impact of pharmacist-initiated change in drug therapy or management quantified by independent panel

	Intervention #, ##		Impact	
	Number (% total interventions)		Increase	Decrease
	Increase	Decrease		
Length of stay				
General bed-day	0 (0)	66 (4.7)	0	65 461
High dependency bed-day	0 (0)	22 (1.6)	0	84 846
Re-admission	3 (0.2)	156 (11.2)	1 137	111 848
Drugs	1043 (74.6)	999 (71.4)	7 964	8 279
Laboratory monitoring	160 (11.4)	128 (9.1)	4 558	4 213
Medical procedures	3 (0.2)	24 (1.7)	88	2 321
Total			13 747	276 968
Overall savings				263 221
Annualized savings				4 444 794
Pharmacist costs				11 457
Annualized pharmacist costs				193 602

a number of interventions impacted on more than one resource quantified; ## A total of 1399 episodes of pharmacist initiated changes to drug therapy or patient management were documented during 24 866 inpatient separations.

This included savings of \$150 307 for reduction in LOS and \$111 848 for avoided admissions.

The average time spent by clinical pharmacists in preparing, undertaking and documenting an intervention was 9.6 min (range 0–60min). This accounted for 3.8% of the time allocated to clinical activities with an associated cost of \$11 457. The annual savings over the eight sites was \$4 447 947 with comparative pharmacist costs of \$193 602.

Discussion

This is the first prospective multisite cost-analysis of clinical pharmacist-initiated changes in drug therapy or patient management for hospitalized patients that has been performed in major Australian acute care government funded hospitals.

This study only quantified savings for interventions where a direct link to utilization of specific health resources was identified and confirmed. Although a number of patients derived other health outcome benefits from the interventions, these outcomes were not quantified in economic terms. In many cases, improvement in treatment efficacy or reduction in symptoms were observed, but as these did not have an impact on LOS, potential readmission, drug costs, or the number of medical procedures or laboratory tests, these were not costed.

The interventions had an impact on patient health outcomes, as more than one quarter were judged to be

of major clinical significance, with 1.1% deemed life saving. These results are consistent with the Quality in Health Care Study that demonstrated that approximately a quarter of adverse events relating to medication in hospitalized patients resulted in permanent disability and that nearly half of these are preventable [3, 4]. In addition, the magnitude of the results in terms of clinical significance are similar to other studies that have examined impact of prescribing errors in hospital inpatients [30].

Reduction in LOS accounted for the majority of the savings measured. This is not surprising as increased LOS has been consistently associated with suboptimal medication use [1–3] and a large proportion of the interventions were initiated to either reduce adverse events or increase treatment efficacy and were considered to have been of moderate or major clinical significance. Reducing LOS may result in increased patient throughput, which in turn could result in an overall increase in hospital expenditure. This could be one argument that these interventions would not result in savings that could be realized for the individual hospital overall. However, it must be acknowledged that the expenditure on the individual patient would be less when interventions occurred. The hospital would save on these patients and, in Australia, further throughput activity would be balanced by case-based funding streams. Benefits of the interventions performed by pharmacists in this study not only include the savings associated with

Table 5

Most frequent services avoided or initiated

	Episodes
<i>Admissions avoided (DRG classification)</i>	
Poisoning/toxic effects of drugs, age > 59 years with complicating comorbidities	11
Heart failure and shock	9
Miscellaneous metabolic disorder without complicating comorbidities	9
Chronic obstructive airway disease	5
Unstable angina without complicating comorbidities	5
Coagulation disorder, age > 69 years	5
<i>Laboratory monitoring changed</i>	
Gentamicin blood concentrations	96
Vancomycin blood concentrations	38
Tobramycin blood concentrations	22
Urea and electrolytes	21
<i>Procedures avoided</i>	
Administration of blood or bone marrow already collected	12
Oesophagoscopy, gastroscopy, duodenoscopy or panendoscopy with or without biopsy	6
Bronchoscopy with one or more endobronchial biopsies or other diagnostic or therapeutic procedures	3
Oesophagoscopy, gastroscopy, duodenoscopy or panendoscopy (1 or more such procedures), with 1 or more of the following endoscopic procedures – polypectomy, removal of foreign body, diathermy, heater probe or laser coagulation, or sclerosing injection of bleeding upper gastrointestinal lesions	2
Lung ventilation study using aerosol, technegas or xenon gas, with planar imaging and single photon emission tomography or planar imaging or single photon emission tomography (R)	2

reducing the duration of hospitalization but also the associated positive outcome of the ability to treat more patients.

Over 10% of the interventions were deemed to have reduced the potential for readmission, and hence, significant costs were avoided. There were a range of different interventions that contributed to reducing potential for re-admission. These included, for example, initiation of prophylactic therapies (such as antibiotics), and instances where continuing therapy was not prescribed but the omission was detected by the pharmacist and therapy recommenced. A number of studies have shown that a large number of hospital admissions are due to adverse drug events, concordance problems, medication

errors or suboptimal prescribing [1–5, 31, 32]. This study supports the concept that clinical pharmacy services provided to admitted patients reduced future healthcare costs.

There was little change in overall expenditure on drugs as a consequence of the interventions, as initiation of drug therapy occurred at a similar rate to cessation of existing therapy. Changes to drug therapy were primarily for clinical reasons and although in many cases involved the initiation of therapy with resultant increase in drug costs, a large number of cases were deemed to have resulted in reduction in LOS and/or reduced probability of readmission. In contrast, formulary restrictions, which contributed more so to reduced drug costs were very much secondary considerations. The clinical significance and the major impact on LOS and potential for readmission were reflective of the clinical focus and proactive nature of the interventions and demonstrate a quality use of medicines approach by the clinical pharmacy services provided. A similar finding was demonstrated in the ambulatory setting by Malone *et al.* [15]. Studies that have demonstrated significant savings in drug costs by pharmacists have had a cost containment focus and have not independently quantified clinical and economic impact on other resources [11, 33].

Interventions did not have a major overall impact on the number, and consequently, the cost of either laboratory tests or medical procedures. Therapeutic drug monitoring was the laboratory test most frequently changed, primarily for additional blood level sampling which resulted in increased costs for this particular resource but in some cases was offset by reductions in LOS. The impact of these interventions are important as inadequate monitoring of drug concentrations has been shown to be one of the more common reasons for drug-related injury in hospitalized patients [3]. The number of medical procedures avoided or increased was small. It is possible this figure was an underestimate, as the independent panels only reviewed cases referred by the intervening clinical pharmacist. The clinical pharmacist may not have always been aware that medical procedures may have been avoided, and consequently no value would have been assigned.

This study was not randomized as clinical pharmacy services are provided routinely to admitted patients in major acute care government funded hospitals in Australia. Randomization of the interventions or patients would have required withdrawal of clinical pharmacy services and this would not have been supported ethically by the participating institutions. Very few studies involving analysis of clinical pharmacy services have incorporated randomizations in the methodology for

these practical reasons. When randomization has been applied, the intervention group has received a new intervention, i.e. clinical pharmacist service initiated where previously none existed [15] or when randomization related not to interventions impacting on patient care but rather cost avoidance with the control group simply observed [33].

It was the responsibility of an independent review panel, convened at each site, to assess the impact of interventions. This method of evaluation of pharmacists' interventions by a multidisciplinary panel is an approach utilized by other investigators [16, 18, 34–36]. Panel assessment was not based around specific defined criteria as the impact quantified was postulated to be suitable and accurate as the panel members had timely access to detailed patient medical information, knowledge of local policies and local practice experience. Although an alternative approach could have seen the treating consultant estimate the impact of the intervention, the high potential for bias may have influenced the results. A central panel was considered, however, logistic considerations and limitations in knowledge of local practices would have been significant. The individual panels were in agreement with the intervening pharmacists on the impact of the change in therapy or management initiated for over three quarters of the cases reviewed. Agreement was strongest for the assessment of LOS in high dependency wards and weakest for potential readmission. The latter is postulated as a reflection of an overestimate of relative risk from the pharmacist's perspective. There was no test of agreement between the different panels as this would be technically difficult as local knowledge and access to individual records would have been a requirement. It was therefore not practical to conduct a comprehensive sensitivity analysis of the impact of different estimates of changes such as length of stay.

There were a number of assumptions in the costing methodology. These included the use of the State government DRG reimbursement, where individual hospital costs for a DRG were not available, and use of the MBS reimbursement rate where a hospital cost was not available. The use of either would result in a conservative measure of costs as these are based on previous year's costings and frequently underestimate actual costs. As noted earlier, savings have been allocated as a direct result of reduction in LOS based on the individual hospitals average bed day costs for the type of bed.

In this study clinical pharmacists reported their own activities. It is possible that as nonindependent observers, their perception of situations reported or not reported may have been influenced. Referrals to the

review panel were, to a large extent, dependent on the experience of the clinical pharmacist making the intervention and on the interpretation made by the coordinating pharmacist at each site. If the clinical pharmacist did not refer an intervention to the review panel, there was no opportunity to quantify a benefit or cost. This might be the case when the intervening pharmacist was unaware of medical procedures that may have been planned or considered. This potential bias would have resulted in an underestimate of the overall benefit.

It is important to note that the potential savings quantified arose from pharmacist-initiated interventions that resulted from only 3.8% of the pharmacist's clinical practice time. Benefits arising from other activities performed in the remainder of their time, such as the provision of drug information, patient medication counselling, staff education, drug use evaluation, research, student education and training, dispensing and administrative work were not the subject of this study and consequently were not quantified.

When annualized, the savings resulting from the interventions quantified at the eight sites was \$4 444 794. For every dollar spent on a pharmacist to initiate changes in drug therapy or management, approximately \$23 was saved on the five areas quantified in this study. Even if total clinical pharmacy service costs, such as total time the pharmacist spent on other clinical activities, including education, clinical rounds, meetings and counselling patients, are taken into account the savings are still in excess of pharmacist costs. The 'annualization' of costs and savings was based on the assumption that the period of the study reflected practices and clinical workloads that were consistent throughout the year.

The magnitude of the savings determined in this study is comparable with those of other smaller published studies [11, 33, 37–39] and is demonstrated over a much larger and broader patient population. Additionally, in some of these studies the resources quantified also included physician and nursing time [37, 38]. Overall, this study has demonstrated a conclusion based on conservative assumptions with the actual savings likely to be significantly greater than those reported and quantified. It must be noted that the clinical activity of therapeutic interventions is an integral component of a clinical pharmacy service and cannot be effectively performed as an isolated activity.

This study clearly demonstrates that routine clinical pharmacist review of inpatient drug therapy is an essential component of the quality use of medicines with a significant potential to reduce LOS and potential for readmission.

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Appendix 1

Hospitals participating in the study

Austin and Repatriation Medical Centre (Victoria)
 Geelong Hospital (Victoria)
 St Vincent's Hospital Sydney (New South Wales)
 Royal North Shore Hospital (New South Wales)
 Royal Brisbane Hospital (Queensland)
 Fremantle Hospital (Western Australia)
 Royal Perth Hospital (Western Australia)
 Royal Hobart Hospital (Tasmania)